

# ASTM Standards on Color and Appearance

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# ASTM International

- Founded in 1898
- One of the largest voluntary standards development organizations in the world
- More than 12,000 standards published each year
- More than 30,000 technical experts from more than 100 countries
- 139 technical committees



# Committee E12 on Color and Appearance

To promote knowledge of color and appearance properties and characteristics, and to encourage the improvement and development of standards for describing and evaluating color and appearance properties by:



# Committee E12 on Color and Appearance

- \* Stimulating and sponsoring research into color and appearance problems;
- \* Formulating terms, nomenclature, and definitions generally applicable for describing color and appearance;



# Committee E12 on Color and Appearance

- \* Developing, or coordinating with other technical committees to develop standards for measuring fundamental and general properties;
- \* Assisting other technical committees to improve color and appearance standards and specifications by advice, suggestions, and dissemination of information;



## Committee E12 on Color and Appearance

- \* Reviewing and recommending approval or revision of ASTM standards, existing or proposed, involving color and appearance factors;
- \* Serving, with the approval of the ASTM Board of Directors, as liaison agent between the Society and other organizations in matters concerned with factors of color and appearance.



# E12 Technical Subcommittees

- E12.01 on Terminology
- E12.02 on Spectrophotometry and Colorimetry
- E12.03 on Geometry
- E12.04 on Color and Appearance Analysis
- E12.05 on Fluorescence
- E12.06 on Image Based Color Measurement
- E12.07 on Color Order Systems



## E12 Technical Subcommittees

- E12.08 on High Visibility Materials for Individual Safety
- E12.10 on Retroreflection
- E12.11 on Visual Methods
- E12.12 on Metallic and Pearlescent Colors
- E12.13 on Photoluminescent Safety Markings
- E12.14 on Multidimensional Characterization of Appearance
- E12.93 on Precision and Bias





# Categories of E12 Standards

## ■ Terminology Standard

- Definitions of terms; explanations of symbols; abbreviations; acronyms
- E284 Standard Terminology of Appearance (E12.01)

## ■ Guides

- Informative; series of options that do not recommend a specific course of action
- E2030 Standard Guide for Recommended Uses of Photoluminescent (Phosphorescent) Safety Markings (E12.13)



# Categories of E12 Standards

## ■ Practices

- A definitive set of instructions for performing one or more specific operations that do not produce a test result.
- E2175 Standard Practice for Specifying the Geometry of Multiangle Spectrophotometers (E12.03)

## ■ Test Methods

- A definitive procedure that produces a test result.
- E1331 Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry (E12.02)



# Categories of E12 Standards

## ■ Specifications

- An explicit set of requirements to be satisfied by a material, product, system, or service
- E1501 Standard Specification for Nighttime Photometric Performance of Retroreflective Pedestrian Markings for Visibility Enhancement (E12.08)



## Classification and Balance

- Committees and subcommittees developing standards dealing with materials, products, systems, or services which are offered for sale are required to be classified and balanced. Classified subcommittees shall consist of not less than three producers and not less than three non-producers.
- E12 is a classified committee
- E12.08 and E12.13 are classified subcommittees



# Classification and Balance

## ■ Producers

- A member who represents and organization that manufactures, fabricates, sells supplies or promotes materials, products, assemblies or services covered by the subcommittee scope.
- Companies or individuals manufacturing instruments, light booths or producing software used to do color and/or appearance testing.

## ■ User

- A member who represents and organization that purchases or uses materials products, assemblies or services covered by the subcommittee scope.



# Classification and Balance

- General Interest
  - A member that does not fit into any of the preceding categories shall be classified as a general interest member.



# The Process Of Creating A Standard

- The subcommittee determines the need for a new standard.
- A task group drafts the standard.
- The draft is submitted for editorial review.
- The draft is placed on a subcommittee ballot.
- Subcommittee members vote on the draft.
  - Affirmative
  - Affirmative with comments
  - Negative
  - Abstain



# The Process Of Creating A Standard

- Negative votes
  - Must be accompanied by an explanation of why the voter cast the negative vote.
  - Should contain alternative wording that would satisfy the negative voter if incorporated into the draft.
  - All negative votes must be resolved.
    - Accepted. Changes will be made to the draft
    - Found non-persuasive and changes will not be made.
- All comments are considered by the subcommittee but will not prevent the draft from going to the next level.





# The Process Of Creating A Standard

- If persuasive negative votes were cast, the draft is revised and put onto a subcommittee ballot.
- Once the draft passes a subcommittee ballot with no negative votes, it is placed onto a committee ballot.
- Committee members vote on the draft.
- Negative votes must be resolved by the originating subcommittee.
- Comments will be reviewed.



# The Process Of Creating A Standard

- If any persuasive negative votes were cast, the draft will be revised and re-balloted.
- If no persuasive negative votes were cast but negative votes cast were found to be non-persuasive by the subcommittee, the non-persuasive finding must be upheld by the entire committee.
- The procedure for finding the negative vote non-persuasive will also be reviewed by the ASTM Committee on Standards.



# The Process Of Creating A Standard

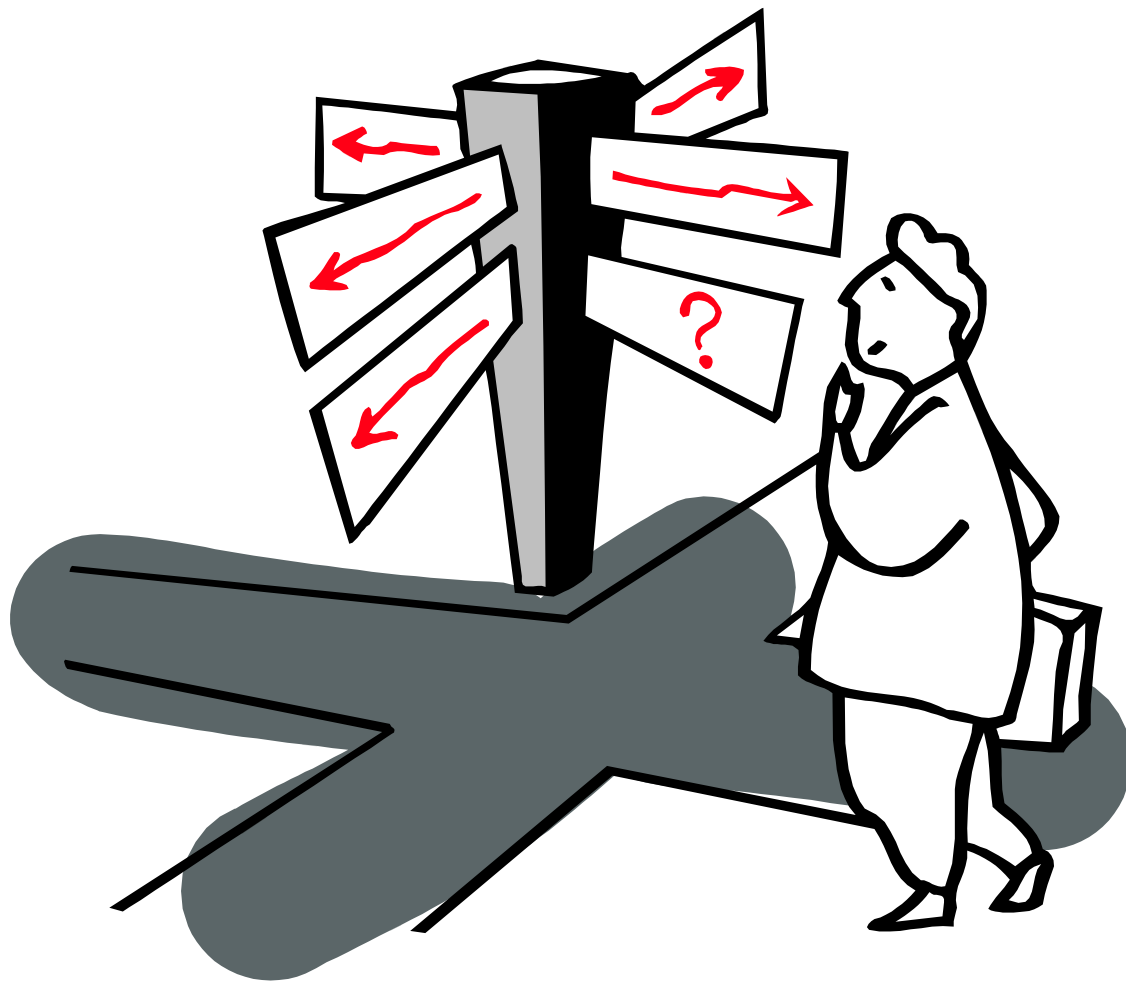
- All members of ASTM International have the opportunity to review the standard before publication and comment or cast a negative vote. Negative votes cast at the ASTM level must be resolved before publication of the standard.
- When the draft has been reviewed and accepted at all levels, the draft becomes an ASTM standard and is published.
- Standards may be revised at any time following publication.



# Mandatory Review Of Standards

- A standard must be reviewed by the responsible subcommittee and balloted for reapproval, revision, or withdrawal within five years of its last approval date.
- If no action has been taken by January 1<sup>st</sup> of the sixth year, ASTM will automatically ballot the standard for withdrawal.
- If the standard has not received a new approval date by December 31<sup>st</sup> of the eighth year since its last approval date, the standard will be withdrawn by ASTM.





## Scope E12.01 on Terminology

Subcommittee E12.01 on Terminology is responsible for the upkeep of E 284, Standard Terminology of Appearance. The subcommittee is actively managing this standard to provide reliable definitions for terms used in new and revised E12 standards and other documents relating to the description of appearance. Terms relating to perception, gonioappearance, instrument agreement, and fluorescence are of particular interest at present. Special care is being taken to promote agreement with the forthcoming revision of the CIE International Lighting Vocabulary, and cooperation with the new CIE Division 8 on Imaging Technologies is expected to generate additional opportunities for standardizing terminology relating to appearance.



## E12.02 on Spectrophotometry and Colorimetry

ASTM Subcommittee E12.02 on Spectrophotometry and Colorimetry actively maintains ASTM Practices and Test Methods that reflect the current state of the art in instrumental colorimetric measurement and assessment. The subcommittee embraces absolute standards, instrumentation and measurement methodologies.



## E12.03 on Geometry

ASTM Subcommittee E12.03 on Geometry is responsible for geometric aspects of ASTM standards on color and appearance. With respect to appearances, people often say, "It all depends on how you look at it." In this committee, that is not taken figuratively, but quite literally. Many materials have different colors, gloss, luster, sheen, or glitter, depending on the angular conditions of illumination and viewing. For this reason, standard methods of viewing materials and standard methods of measuring physical quantities that correlate with visual observations must specify geometry precisely. The subcommittee standardizes concepts, terminology, and notation for specifying the geometry for viewing and measuring materials and assists other subcommittees with the geometric aspects of standardization.





## E12.04 on Color and Appearance Analysis

Subcommittee E12.04 on Color and Appearance Analysis is responsible for developing and maintaining standard practices that involve the numerical or mathematical manipulation of color measurement data. These standards include the derivation of tristimulus values, color space coordinates, scales of yellowness, whiteness, and color differences. Much of the research in colorimetry involves the comparison and modeling of the objective measurement of light stimuli with the subjective visual response to those stimuli. As that research is introduced into the public domain, this subcommittee attempts to document and standardize the practical aspects that will improve the communication of color across the design, production and marketing applications. Our standards include E 308 on computing the colors of objects by using the CIE System, E1345 on reducing the variability of color measurement by use of multiple measurements and E 1708 on electronic interchange of color and appearance data.



## E12.05 on Fluorescence

ASTM subcommittee E12.05 on Fluorescence is actively working to update the existing standard practices and test methods to reflect the current state of the art for the colorimetry of fluorescent materials. There is a major revision of ASTM E 1247 on identifying fluorescence in object-color specimens in progress. The subcommittee is also working on the development of new standards including: a proposed guide to fluorescence and the colorimetry of fluorescent materials that can be used as reference by industry to understand what fluorescence really is and the issues involved in the accurate and reproducible color measurement of these materials, and a proposed method for the measurement of fluorescent materials using the two-monochromator method. The objective of this method is to describe these different procedures now in use which will then serve as a starting point for evaluating the relative accuracy of each method.



## E12.06 on Appearance of Displays

Subcommittee E12.06 on Appearance of Displays is responsible for standards that ensure accurate and consistent measurement of information displays. These interests range from standard test methods for obtaining spectroradiometric data to guides to the modeling of display properties and performance. CRTs, flat panel displays, and photographic imaging systems each have special characteristics that challenge users of measurement equipment. The subcommittee finds consensus as to how proper measurements should be made and interpreted.



## E12.07 on Color Order Systems

Subcommittee E12.07 develops and maintains test methods, practices and guides relating to the use of color order systems and determining the notations of colors in respect to various color order systems. Current practices describe the Munsell Color Order System, the Color Curve System and the Optical Society of America Uniform Color Scales System.



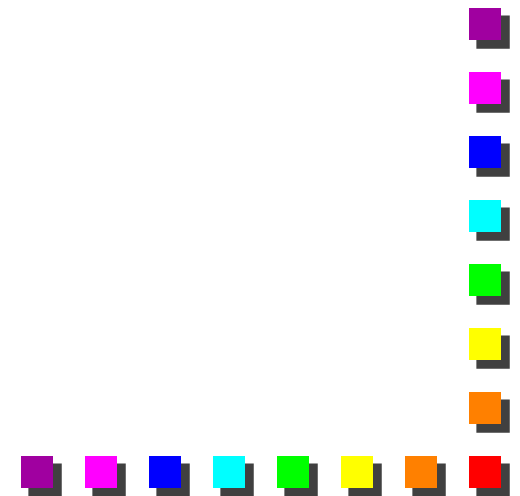
## E12.11 on Visual Methods

E12.11 on Visual Methods is concerned with looking at things, judging what we see, and then describing it analytically. This is psychophysics, the systematic, quantitative study of human perceptual response. A major variable is the multiplicity of light sources. Their light is usually modulated by the reflectance or transmittance characteristics of object before it impacts upon our visual system. We are well along toward agreement upon what is best for judging a test (new) source mimics. The color rendering of an existing (old) reference source, a Color Rendering Index.



## E12.13 Photoluminescent Safety Markings

Subcommittee E12.13 develops standards relating to photoluminescence. These documents help manufacturers, users, architects, designers, code officials and other interested parties test, specify and use true photoluminescent safety markings for life-safety related applications.



## E12.14 on Multidimensional Characterization of Appearance

Modern coating and polymer chemistry and application techniques result in surface and sub-surface appearance phenomena which, individually and in combination, defy adequate specification (or characterization) visually and instrumentally. This limits (hinders) our ability to define and consistently reproduce products of desirable quality, or to analyze and exclude unwanted appearance effects. This committee desires to expand our knowledge of this complex subject and develop visual and instrumental standards based on well founded data.



## E12 Standards

### E12.01 Terminology

E284-06b Standard Terminology of Appearance

### E12.02 Spectrophotometry and Colorimetry

E259-06 Standard Practice for Preparation of Pressed Powder White Reflectance Factor Transfer Standards for Hemispherical and Bi-Directional Geometries

E1164-02 Standard Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation

E1331-04 Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry

E1347-03 Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry

E1348-02 Standard Test Method for Transmittance and Color by Spectrophotometry Using Hemispherical Geometry

E1349-06 Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45:0 or 0:45) Geometry

E1477-98a(2003) Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers





## E12 Standards

### E12.03 Geometry

D523-89(1999) Standard Test Method for Specular Gloss

E179-96(2003) Standard Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials

E312-06 Standard Practice for Description and Selection of Conditions for Photographing Specimens Using Analog (Film) Cameras and Digital Still Cameras (DSC)

E430-05 Standard Test Methods for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry

E1767-04 Practice for Specifying the Geometries of Observation and Measurement to Characterize the Appearance of Materials

E2175-01 Standard Practice for Specifying the Geometry of Multiangle Spectrophotometers

E2387-05 Standard Practice for Goniometric Optical Scatter Measurements



## E12 Standards

### E12.04 Color and Appearance Analysis

D2244-05 Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

E308-01 Standard Practice for Computing the Colors of Objects by Using the CIE System

E313-05 Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates

E805-06 Standard Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials

E1345-98(2003) Standard Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements

E1708-95(2001) Standard Practice for Electronic Interchange of Color and Appearance Data

E2022-06 Standard Practice for Calculation of Weighting Factors for Tristimulus Integration

E2214-02 Standard Practice for Specifying and Verifying the Performance of Color-Measuring Instruments

E2222-02 Standard Practice for Host Computer Communication with Spectrometers for Color Measurements



## E12 Standards

### E12.05 Fluorescence

E991-06 Standard Practice for Color Measurement of Fluorescent Specimens Using the One-Monochromator Method

E1247-03 Standard Practice for Detecting Fluorescence in Object-Color Specimens by Spectrophotometry

E2152-01(2006) Standard Practice for Computing the Colors of Fluorescent Objects from Bispectral Photometric Data

E2153-01(2006) Standard Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color

E2301-03 Standard Test Method for Daytime Colorimetric Properties of Fluorescent Retroreflective Sheeting and Marking Materials for High Visibility Traffic Control and Personal Safety Applications Using 45°:Normal Geometry

E2501-06 Standard Specification for Light Source Products for Inspection of Fluorescent Coatings

WK9414 Standard Specification for Light Source Products for Inspection of Fluorescent Coatings (In Progress)

WK10687 Standard Practice for the Determination of Luminance under Monochromatic LED Illumination (In Progress)



## E12 Standards

### E12.06 Image Based Color Measurement

E1336-96(2003) Standard Test Method for Obtaining Colorimetric Data From a Visual Display Unit by Spectroradiometry

E1341-06 Standard Practice for Obtaining Spectroradiometric Data from Radiant Sources for Colorimetry

E1455-03 Standard Practice for Obtaining Colorimetric Data from a Visual Display Unit Using Tristimulus Colorimeters

E1682-05 Standard Guide for Modeling the Colorimetric Properties of a Visual Display Unit

E2466-06 Standard Test Method for Colorimetry of Teeth Using Digital Still Camera Technology

WK7943 Standard Test Method for Colorimetry of Teeth Using Digital Still Camera Technology (In Progress)

WK11946 Objective Quantification of Dental Plaque Using Digital Still Cameras (In Progress)

WK11947 Standard Test Method for Objective Measurement of Gingival Color Using Digital Still Cameras (In Progress)



## E12 Standards

### E12.07 Color Order Systems

D1535-06 Standard Practice for Specifying Color by the Munsell System

E1360-05 Standard Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System

E1541-98(2003) Standard Practice for Specifying and Matching Color Using the Colorcurve System

### E12.08 High Visibility Materials for Individual Safety

E1501-99(2004) Standard Specification for Nighttime Photometric Performance of Retroreflective Pedestrian Markings for Visibility Enhancement

### E12.10 Retroreflection

D4061-94(2006) Standard Test Method for Retroreflectance of Horizontal Coatings

E808-01 Standard Practice for Describing Retroreflection

E809-02 Standard Practice for Measuring Photometric Characteristics of Retroreflectors

E810-03 Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry



## E12 Standards

### E12.10 Retroreflection Continued

E811-95(2001) Standard Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions

E1696-04 Standard Test Method for Field Measurement of Raised Retroreflective Pavement Markers Using a Portable Retroreflectometer

E1709-00e1 Standard Test Method for Measurement of Retroreflective Signs Using a Portable Retroreflectometer

E1710-05 Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer

E1809-01 Test Method for Measurement of High-Visibility Retroreflective-Clothing Marking Material Using a Portable Retroreflectometer

E2176-01 Standard Test Method for Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Standard Condition of Continuous Wetting

E2177-01 Standard Test Method for Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Standard Condition of Wetness



## E12 Standards

### E12.10 Retroreflection Continued

E2302-03a Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer

E2366-05 Standard Test Method for Measurement of Daytime Chromaticity of Pavement Marking Materials Using a Portable Reflection Colorimeter

E2367-05 Standard Test Method for Measurement of Nighttime Chromaticity of Pavement Marking Materials Using a Portable Retroreflection Colorimeter

WK360 Test Method for Coefficient of Retroreflection of Retroreflective Sheeting for Flat Vertical Application (In Progress)

WK3833 Test Method for determination of the coefficient of retroreflection of pavement markings using a 30 meter geometry mobile retroreflectometer. (In Progress)

WK7508 Test Method for Retroreflectance of Pavement Marking Materials Utilizing the Beam Method (In Progress)

WK9050 Standard Test Method for Measurement of Retroreflective Signs Using a Portable Retroreflectometer at a 0.5 degree observation angle (In Progress)



## E12 Standards

### E12.11 Visual Methods

D1729-96(2003) Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials

D2616-96(2003) Standard Test Method for Evaluation of Visual Color Difference With a Gray Scale

D3134-97(2003) Standard Practice for Establishing Color and Gloss Tolerances

D4086-92a(2003) Standard Practice for Visual Evaluation of Metamerism

E1478-97(2003) Standard Practice for Visual Color Evaluation of Transparent Sheet Materials

E1499-97(2003) Standard Guide for Selection, Evaluation, and Training of Observers

E1808-96(2003) Standard Guide for Designing and Conducting Visual Experiments

WK4911 Standard Practice for Estimating the Colorimetric Effects of Light-on-Object Colors (In Progress)





## E12 Standards

### E12.12 Metallic and Pearlescent Colors

E2194-03 Standard Practice for Multiangle Color Measurement of Metal Flake Pigmented Materials

WK1164 Standard Practice for Multiangle Color Measurement of Interference Pigmented Materials (In Progress)

### E12.13 Photoluminescent Safety Markings

E2030-06 Standard Guide for Recommended Uses of Photoluminescent (Phosphorescent) Safety Markings

E2072-04 Standard Specification for Photoluminescent (Phosphorescent) Safety Markings

E2073-02 Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings

### E12.14 Multidimensional Characterization of Appearance

### E12.93 Precision and Bias

WK4106 Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method with Multi-Valued Measurands

